Photochemical Formation of Hydroxyl Radicals in Red Soil-Polluted Seawater on the North of Okinawa Island, Japan

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Abstract

Land development has caused runoff of red soil into the ocean on the north side of Okinawa Island, Japan. In an attempt to clarify the impacts of this "red soil pollution" on the oxidizing power of seawater, we studied the formation of hydroxyl radical (•OH), the most potent oxidant in the environment, in red soil-polluted waters using a 313-nm monochromatic light. •OH was photochemically formed in the red soil-polluted water samples, and the formation rates of •OH decreased as salinity increased, i.e., as red soil-polluted river water gets mixed with seawater. The photo-formation rates of •OH showed good correlations with dissolved Fe concentrations ($R^2 = 0.96$) and $[NO_2^-] + [NO_3^-]$ concentrations ($R^2 = 0.87$), while a negative and weak correlation was found with dissolved organic carbon concentrations ($R = -0.78$). Theoretical calculation showed that direct photolysis of NO_3^-, $Fe(OH)^{2+}$, and hydrogen peroxide all together accounted for less than 10% of the observed •OH formation in the red soil-polluted waters. Comparison between filtered and unfiltered samples showed that red soil particles were not the main sources of •OH, and the photolysis of NO_2^- could account for at most 78% of the observed •OH formation rates. We found that the Fenton's reaction (a reaction between Fe(II) and H_2O_2) could possibly account for the observed formation of •OH in the red soil-polluted waters.

Keywords

Hydroxyl radical Photochemistry Red soil Fenton's reaction Nitrite